MTH203: Geometry

Students learn to recognize and work with geometric concepts in various contexts. They build on ideas of inductive and deductive reasoning, logic, concepts, and techniques of Euclidean plane and solid geometry and develop an understanding of mathematical structure, method, and applications of Euclidean plane and solid geometry. Students use visualizations, spatial reasoning, and geometric modeling to solve problems. Topics of study include points, lines, and angles; triangles; right triangles; quadrilaterals and other polygons; circles; coordinate geometry; three-dimensional solids; geometric constructions; symmetry; the use of transformations; and non-Euclidean geometries.

Compared to MTH202, this course has a more rigorous pace and more challenging assignments and assessments. MTH203 also covers additional topics such biconditionals, rotations of points in a coordinate plane, creating and interpreting truth tables, parametric equations for lines in three dimensions, finding the equation of a circle from three points, input-output tables for logical gates, and several theorems including the Jordan Curve Theorem, Pappus' Theorem, and Desargues' Theorem.

COURSE LENGTH: Two semesters

MATERIALS: *Geometry: A Reference Guide; a drawing compass, protractor, and ruler*

PREREQUISITES: MTH123: Algebra I, or equivalent

SEMESTER ONE

Unit 1: An Introduction

Even the longest journey begins with a single step. Any journey into the world of geometry begins with the basics. Points, lines, segments, and angles are the foundation of geometric reasoning. This unit provides students with basic footing that will lead to an understanding of geometry.

- Semester Introduction
- Basic Geometric Terms and Definitions
- Measuring Length
- Measuring Angles
- Bisectors and Line Relationships
- Relationships between Triangles and Circles
- Transformations
- Using Algebra to Describe Geometry

Unit 2: Methods of Proof and Logic

Professionals use logical reasoning in a variety of ways. Just as lawyers use logical reasoning to formulate convincing arguments, mathematicians use logical reasoning to formulate and prove theorems. With definitions, assumptions, and previously proven theorems, mathematicians discover and prove new theorems. It's like building a defense, one argument at a time. In this unit, students will learn how to build a defense from postulates, theorems, and sound reasoning.

- Reasoning, Arguments, and Proof
- Conditional Statements
- Compound Statements and Indirect Proof
- Algebraic Logic
- Inductive and Deductive Reasoning

Unit 3: Polygon Basics

We can find polygons in many places: artwork, sporting events, architecture, and even in roads. In this unit, students will discover symmetry, work with special quadrilaterals, and work with parallel lines and slopes.

- Polygons and Symmetry
- Quadrilaterals and Their Properties
- Parallel Lines and Transversals
- Converses of Parallel Line Properties
- The Triangle Sum Theorem
- Angles in Polygons
- Midsegments
- Slope

Unit 4: Congruent Polygons and Special Quadrilaterals

If two algebraic expressions are equivalent, they represent the same value. What about geometric shapes? What does it mean for two figures to be equivalent? A pair of figures can be congruent the same way that a pair of algebraic expressions can be equivalent. Students will learn, use, and prove theorems about congruent geometric figures.

- Congruent Polygons and Their Corresponding Parts
- Triangle Congruence: SSS, SAS, and ASA
- Isosceles Triangles and Corresponding Parts
- Triangle Congruence: AAS and HL
- Using Triangles to Understand Quadrilaterals
- Types of Quadrilaterals
- Constructions with Polygons
- The Triangle Inequality Theorem

Unit 5: Perimeter, Area, and Right Triangles

If we have a figure, we can take many measurements and calculations. We can measure or calculate the distance around the figure (the perimeter or circumference), as well as the figure's height and area. Even if we have just a set of points, we can measure or calculate the distance between two points.

- Perimeter and Area
- Areas of Triangles and Quadrilaterals
- Circumference and Area of Circles
- The Pythagorean Theorem
- Areas of Special Triangles and Regular Polygons
- Using the Distance Formula
- Proofs and Coordinate Geometry

Unit 6: Semester Review and Test

- Semester Review
- Semester Test

SEMESTER TWO

Unit 1: Three-Dimensional Figures and Graphs

One-dimensional figures, such as line segments, have length. Two-dimensional figures, such as circles, have area. Objects we touch and feel in the real world are three-dimensional; they have volume.

- Semester Introduction
- Solid Shapes and Three-Dimensional Drawing
- Lines, Planes, and Polyhedra
- Prisms
- Coordinates in Three Dimensions
- Equations of Lines and Planes in Space

Unit 2: Surface Area and Volume

Every three-dimensional figure has surface area and volume. Some figures are more common and useful than others. Students probably see pyramids, prisms, cylinders, cones, and spheres every day. In this unit, students will learn how to calculate the surface area and volume of several common and useful three-dimensional figures.

- Surface Area and Volume
- Surface Area and Volume of Prisms
- Surface Area and Volume of Pyramids
- Surface Area and Volume of Cylinders
- Surface Area and Volume of Cones
- Surface Area and Volume of Spheres
- Three-Dimensional Symmetry

Unit 3: Similar Shapes

A map of a city has the same shape as the original city, but the map is much, much smaller. A mathematician would say that the map and the city are similar. They have the same shape but are different sizes.

- Dilations and Scale Factors
- Similar Polygons
- Triangle Similarity
- Side-Splitting Theorem
- Indirect Measurement and Additional Similarity Theorems
- Area and Volume Ratios

Unit 4: Circles

You probably know what a circle is and what the radius and diameter of a circle represent. However, a circle can have many more figures associated with it. Arcs, chords, secants, and tangents all provide a rich set of figures to draw, measure, and understand.

- Chords and Arcs
- Tangents to Circles
- Inscribed Angles and Arcs
- Angles Formed by Secants and Tangents
- Segments of Tangents, Secants, and Chords
- Circles in the Coordinate Plane

Unit 5: Trigonometry

Who uses trigonometry? Architects, engineers, surveyors, and many other professionals use trigonometric ratios such as sine, cosine, and tangent to compute distances and understand relationships in the real world.

- Tangents
- Sines and Cosines
- Special Right Triangles
- The Laws of Sines and Cosines

Unit 6: Beyond Euclidian Geometry

Some people break rules, but mathematicians are usually very good at playing by them. Creative problem-solvers, including mathematicians, create new rules, and then play by their new rules to solve many kinds of problems.

- The Golden Rectangle
- Taxicab Geometry
- Graph Theory
- Topology
- Spherical Geometry
- Fractal Geometry
- Projective Geometry
- Computer Logic

Unit 7: Semester Review and Test

- Semester Review
- Semester Test